Data Content Standard for Remotely Sensed Ocean Color Data

IOOS Data Integration Framework - 2008

National Oceanic and Atmospheric Administration
Integrated Ocean Observing System Program
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Version 1.1

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Comments and Change Requests

Contact	Comment	Action	Notes
NODC	Edit name of document to "Satellite Chlorophyll DCS"	deferred to IOOS Office	DCS tasking and format change
NCDDC DCS review team	Add nL_w to acromym list	accepted	
NCDDC DCS review team	Add UTC to acronym list	accepted	
CoastWatch Central, CoastWatch West Coast	Narrative Change: Forword paragraph 1, see Comments of Data Content Standard for Remotley Sensed Ocean Color iteration 2.1.3-4 dated 12 June 2008	accepted	
NCDDC DCS review team	Narrative Change: Forword paragraph 1	accepted	
CoastWatch Central, CoastWatch West Coast	Narrative Change: Forword paragrah 2, see Comments of Data Content Standard for Remotely Sensed Ocean Color iteration 2.1.3-4 dated 12 June 2008	accepted	
NODC	Add statement to how DCS was developed	accepted with note	Will expand after user input
CoastWatch Central, CoastWatch West Coast	Narrative Change: Methodology paragraph 1, see Comments of Data Content Standard for Remotely Sensed Ocean Color iteration 2.1.3-4 dated 12 June 2008	accepted	
NODC	Narrative Change: Methodology paragraph 2, see email dated 23 May 2008	accepted	
IOOS Office	Comment on Methodology paragraph 2, Encode lists might not use CSV	deferred to Data Encoding	
NODC	Narrative Change: Data Content paragraph 1, edit DCS to reflect a generalized community, see email dated 23 May 2008	deferred to IOOS Office	DCS Format change
NCDDC DCS review team	Add caveats that the metadata is for the full file	accepted	
IOOS Office	DCS has additional material, is this the right place for it?	No Change	Descriptive information provides some context for the data being captured for a DCS user/reader
NODC	Edit DCS to have DCS first then example Table 1	Deferred to IOOS Office	DCS Format change
CoastWatch Central, CoastWatch West Coast, IOOS Office, NOS/CSC	Remove FILENAME	accepted	Metadata concern
NODC	Missing important field TITLE	deferred to Data Encoding	Comment in context of CF Encoding
IOOS Office	Add MIME TYPE	deferred to Metadata	Format of data either documented in metadata or captured in encoding
NODC	Edit CREATE AGENCY to CREATE INSTITUTION	accepted	
CoastWatch Central, CoastWatch West Coast	Add CREATE EMAIL	deferred to Metadata	Best captured and kept current through the metadata
CoastWatch Central, CoastWatch West Coast	Add CREATE URL	deferred to Metadata	Best captured and kept current through the metadata
CoastWatch Central, CoastWatch West Coast	Edit CREATE TIME DATE to CREATE DATE TIME	accepted	
CoastWatch Central, CoastWatch West Coast	The semantics of CREATE TIME DATE need to be clarified	accepted	
IOOS Office	Remove ‘from origin date 1970-01-01 00:00:00’ from all variables	accepted	Encoding issue
NODC	Edit SENSOR PLATFORM to PLATFORM	No change	Consistent with SENSOR element

NOS/NCCOS	Insufficient map projection information to recreate the file	accepted with note	Map Projection element is in DCS; should be encoded with complete info to identify specific projection
CoastWatch Central, CoastWatch West Coast	Use common strategy for projections, suggested "proj4" from CF and OGC see Comments of Data Content Standard for Remotely Sensed Ocean Color iteration 2.1.3-4 dated 12 June 2008	deferred to IOOS Office	DCS is for integration – common projection needs to be joint consideration with other IOOS variables within DIF
CoastWatch Central, CoastWatch West Coast	Add list of projections and ellipsoids from GCTP package to GEODETIC DATUM, see Comments of Data Content Standard for Remotely Sensed Ocean Color iteration 2.1.3-4 dated 12 June 2008	accepted	
NODC	Objection to description of INPUT FILES	No Change	See below. Not mandatory
NCDDC DCS review team	Change INPUT FILES to optional	accepted	
NOS/CSC	Not clear of necessity of INPUT FILES	addressed in previous comment, deferred to Metadata	
NCDDC DCS review team	Edit Latitude to optional	accepted	
NCDDC DCS review team	Edit Longitude to optional	accepted	
CoastWatch Central, CoastWatch West Coast	Provide the basis vectors in the transformed space for latitude and longitude, see Comments of Data Content Standard for Remotely Sensed Ocean Color iteration 2.1.3-4 dated 12 June 2008	No Change	Encoding step
IOOS Office	Remove “number of decimal places communicates the accuracy of the position”	accepted	
NOS/CSC	Add CORNER COORDINATES	No Change	Intent of the four DCS elements defining the bounding extent of the data
NOS/CSC	Add PIXEL SIZE	No Change in current version	Good comment; Mean pixel size over the image (single value?). Additional comment from users sought
NOS/CSC	Add ROW and COLUMN COUNT	deferred to Encoding	
NOS/CSC	Add BYTE ORDER	deferred to Encoding	
NOS/NCCOS	Did not see any reference to scaling factors. Add SCALING of PHYSICAL PARAMETERS, see email dated 12 June 2008	deferred to Encoding	Scaling depends on how the data is eventually encoded
CoastWatch Central, CoastWatch West Coast	Recommend omitting CHLOROPHYLL, see Comments of Data Content Standard for Remotely Sensed Ocean Color iteration 2.1.3-4 dated 12 June 2008	accepted	
CoastWatch Central, CoastWatch West Coast	Edit CHLOROPHYLL so that the domain does not include an upper bound, see Comments of Data Content Standard for Remotely Sensed Ocean Color iteration 2.1.3-4 dated 12 June 2008	addressed in previous comment	
CoastWatch Central, CoastWatch West Coast	Edit CHLOROPHYLL ALGORITHM to OBSERVED PROPERTY ALGORITHM	accepted	
NCDDC DCS review team	Add units to table of validated ocean color products	accepted	
NCDDC DCS review team	Remove example of units in OBSERVED PROPERTY and refer to units added to table of validated ocean color products	accepted	

CoastWatch Central, CoastWatch West Coast	Discuss and agree on processing level convention, see Comments of Data Content Standard for Remotely Sensed Ocean Color iteration 2.1.3-4 dated 12 June 2008	deferred to IOOS Office	NOAA language derived from FGDC used in current DCS – recommend adopt a convention vice creating new language for DCS
CoastWatch Central, CoastWatch West Coast	Edit PROCESSING FLAGS to optional, see Comments of Data Content Standard for Remotely Sensed Ocean Color iteration 2.1.3-4 dated 12 June 2008	Accepted with note	Data quality indicators should be captured with the data when available
CoastWatch Central, CoastWatch West Coast	Remove NUMBER OF BANDS	No Change	See next comment
NCDDC DCS review team	Edit NUMBER OF BANDS to optional	accepted	
CoastWatch Central, CoastWatch West Coast	Edit NUMBER OF BANDS to NUMBER OF SPECTRAL BANDS	accepted	
CoastWatch Central, CoastWatch West Coast	Remove WAVELENGTHS	No Change	See next comment
NCDDC DCS review team	Edit WAVELENGTHS to optional	accepted	
CoastWatch Central, CoastWatch West Coast	Remove BANDWIDTHS	No Change	See next comment
NCDDC DCS review team	Edit BANDWIDTHS to optional	accepted	
NCDDC DCS review team	Edit BANDWIDTHS and move [bandwidths] from Reference to Encoding Tag	accepted	
CoastWatch Central, CoastWatch West Coast	ATM CORRECTION is properly documented, see Comments of Data Content Standard for Remotely Sensed Ocean Color iteration 2.1.3-4 dated 12 June 2008	No Change	
NODC	Do not abbreviate ATM CORRECTION	No Change addressed in previous comment	
NODC	Questioned why Figure E-1 was included	addressed in previous comment	
CoastWatch Central, CoastWatch West Coast	Add ANCILLARY DATA	accepted	
NODC	Missing important field COMMENTS, see email dated 28 May 2008	addressed in previous comment	
CoastWatch Central, CoastWatch West Coast, NCDDC DCS review team	Add to notes what element links to in netCDF	accepted with note	Part of mapping DCS to encoding or part of DCS?
NCDDC DCS review team	Add 'bit' to length to clarify	accepted	
NOS/NCCOS	Unclear of why float lengths read 64	addressed in previous comment	
NCDDC DCS review team	Edit table B-1 to break out sensor and sensor platform	accepted	
NOS/CSC	Edit or delete table B-2 to consider EPSG convention to define projections	No Change; deferred to IOOS Office	EPSG convention adopted across the DIF?
NODC, NCDDC DCS review team	Edit Figure D-1	accepted	
NCDDC DCS review team	Update table numbers	accepted	
NODC	The first section of the DCS is global attributes, DCS should focus on requirements for variables. Mandate the use of CF.	deferred to IOOS Office	Format change
CoastWatch Central, CoastWatch West Coast	Consider alternative transport protocols	deferred to Data Encoding	
NOS/CSC	Review HABs process to ensure DCS meets those as a min	accepted	Working June 2008
NOS	Add Ellipsoid, Longitude of Central Meridian, Latitude of True Scale, False Easting, False Northing, Standard Parallel, Pixel Size.	accepted	Added as sub-elements of Map Projection and Pixel Size as new element
NCDDC DCS review team	Add a table of the minimal elements	accepted	Table 1
NODC	Paragraph 1 pg 7 change "5 arcminute" to "5 minute." Verify operation dates in Tables B-1 and B-2.	accepted	corrected text

Acronyms

CSV	Comma Separated Value
DCS	Data Content Standard
DIF	Data Integration Framework
GAC	Global Area Coverage
HDF	Hierarchical Data Format
IOOS	Integrated Ocean Observing System
LAC	Local Area Coverage
MERIS	Medium Resolution Imaging Spectrometer
MODIS	Moderate Resolution Imaging Spectroradiometer
NESDIS	National Environmental Satellite, Data, and Information Service
nL_w	Normalized Water Leaving Radiance
NOAA	National Oceanic and Atmospheric Administration
OCM	Ocean Colour Monitor
SeaWiFS	Sea-viewing Wide Field-of-view Sensor
USDOC	United States Department of Commerce
UTC	Coordinated Universal Time

Foreword

Ocean color is described by the spectrum of water-leaving radiances. Ocean color observations are made by acquiring and measuring various visible and near infrared wavelength radiances, calculating and subtracting atmospheric and reflectance corrections. The resulting normalized water leaving radiances (nL_w) are combined to derive other ocean parameters such as chlorophyll concentrations and other bio-optical or geophysical products. The contribution of nL_w is less than 10% of the top-of-the-atmosphere radiation detected by the sensor on a satellite. As a result, processing remotely sensed ocean color from space requires numerically robust, rigorous and detailed efforts to ensure adequate accuracy. The resulting ocean color data products are used in assessing ecosystems and primary productivity, and generally tracking temporal and spatial variability in the ocean on scales not available through *in situ* observations.

Under this Data Content Standard (DCS) the derived ocean color parameter for inclusion in the Integrated Ocean Observing System (IOOS) Data Integration Framework (DIF) Project is chlorophyll concentration. Chlorophyll a concentration can be used as a proxy for the abundance of phytoplankton. Bio-optical algorithms relate observed spectral ocean color to biological ocean properties. Traditionally, chlorophyll concentration bio-optical algorithms have used the reflectance ratio between blue and green wavelengths to arrive at a concentration, relying on the fact that chlorophyll absorbs mostly in the blue wavelengths and reflects green light. Accuracy is an inherent consideration for data integration. In oceanic waters, satellite-derived estimates of chlorophyll concentrations are more accurate as chlorophyll tends to be the dominant optically active constituent. In coastal waters, other optically active constituents such as suspended sediments and color dissolved organic mater (CDOM) tend to decrease the absolute accuracy of chlorophyll retrievals. However, the time and space resolution of remotely-sensed chlorophyll estimates remain useful for measuring the extent of biological processes such as algal blooms and decay. [Muller-Karger et al. (2005)]

Methodology

In compiling this DCS, several ocean color products were reviewed from multiple sensors and platforms. Base files used in the processing to create these chlorophyll concentration products had different spatial processing extents. MODIS has 5 minute granules in HDF, MERIS has full resolution at 300m and reduced resolution at 1200m, SeaWiFS has Local Area Coverage (LAC) at 1100m at nadir and Global Area Coverage (GAC) at 4000 m, and the Ocean Colour Monitor (OCM) has a spatial resolution of 350m.

This DCS is divided into several parts. The first table shows the recommended elements that should be provided for ocean color data. The data dictionary, that follows, describes each of these elements along with optional elements that can be included to provide a better understanding of the data. There are several Appendices. Appendix A shows an example of this DCS for an ocean color data file. Appendix B provides tables of valid domains; these tables appear in the order in which they are referenced within the Data Dictionary. Appendix C provides a table showing the sources of ocean color products.

Appendices D and E show figures illustrating data acquisition time and atmospheric correction, respectively.

Future Work

Some data dictionary entries list an “encoding tag” designation. Encoding tags are not completed in this version as these will be addressed by the DIF’s Web Services and Data Encoding Working Group. Suggested tag name are provided in some cases. Encoding tag recommendations appear in brackets [].

Data Content

This DCS identifies the information necessary to convey the characteristics of remotely sensed ocean color (chlorophyll) data including things like collection sensor and platform, data processing, data quality, timeframe, and locations. This DCS is intended for a full dataset and not subsets of the data.

Table 1 lists the minimum elements for a remotely sensed ocean color dataset. Each of these elements are described in the Data Dictionary section of this DCS. An example of these elements completed based on a CoastWatch chlorophyll dataset and other optional elements is shown in Table 2. Note that blank fields illustrate additional information that are made available by other data providers and should be considered by CoastWatch.

Table 1: Minimal Data Content for Remotely Sensed Ocean Color Data

Element
CREATE INSTITUTION
CREATE DATE TIME
AQUISITION START DATE TIME
ACQUISITION END DATE TIME
SENSOR
SENSOR PLATFORM
MAP PROJECTION
GEODETIC DATUM
NORTHERN LATITUDE
SOUTHERN LATITUDE
WESTERN LONGITUDE
EASTERN LONGITUDE
OBSERVED PROPERTY
OBSERVED PROPERTY ALGORITHM
PROCESSING LEVEL

Table 2: Data Content Standard for Ocean Color Data Content using a CoastWatch Data File

Element	Example
CREATE INSTITUTION	USDOC/NOAA/NESDIS CoastWatch
CREATE DATE TIME	2008-05-06T13:05:07Z
AQUISITION START DATE TIME	2008-05-06T11:20:07Z
ACQUISITION END DATE TIME	2008-05-06T13:05:07Z
SENSOR	MODIS
SENSOR PLATFORM	Terra
MAP PROJECTION	Albers Conical Equal Area
ELLIPSOID*	
LONG OF CENTRAL MERIDIAN*	
LAT OF TRUE SCALE*	
FALSE EASTING*	
FALSE NORTHING*	
STANDARD PARALLEL*	
GEODETIC DATUM	WGS-84
PIXEL SIZE*	
INPUT FILES*	GulfofMexicoAlbers.hdf, MODSCW.A2008127.1620.hdf
LATITUDE*	30.9284265727064,31.215834125863008,31.311826813837126, 31.215834125863008, 27.44235270893699,23.967082426732215, 20.489504563418613,16.997519701936284
LONGITUDE*	-100.14043940487096,-94.57891086074866,-89.0 -83.42108913925131,-77.85956059512901,-78.16794976127227, -78.45975610311781,-78.73627984194691
NORTHERN LATITUDE	31.311826813837126
SOUTHERN LATITUDE	16.997519701936284
WESTERN LONGITUDE	-100.14043940487096
EASTERN LONGITUDE	-77.85956059512901
OBSERVED PROPERTY	Chlorophyll Concentration
OBSERVED PROPERTY ALGORITHM	OC3
PROCESSING LEVEL	Level 3
PROCESSING FLAGS*	
NUMBER OF SPECTRAL BANDS*	
WAVELENGTHS*	
BANDWIDTHS*	
ATM CORRECTION*	
CALIBRATION*	
ANCILLARY DATA*	

*** indicates optional elements. Elements left blank were not available from CoastWatch example files.**

Data Dictionary

Each data content element is described in the following data dictionary. This data dictionary contains definitions, units of measure, valid domains, examples, obligations, occurrences, suggested encoding tags, references, and additional notes. If an element is mandatory and cannot be repeated, the occurrence is noted by a '1'. If an element is repeatable, it is noted by an 'N' and should be listed in comma separated values (csv). References correspond to the documents and web resources noted at the end of this document. Notes accompanying each entry provide some background information and justification for including the element.

CREATE INSTITUTION

Description:	Name of the organization or agency that developed the dataset
Data Type:	xsd:string
Length:	Unbounded
Units:	N/A
Domain:	N/A
Example:	USDOC/NOAA/NESDIS CoastWatch
Obligation:	Mandatory
Occurrence:	N
Encoding Tag:	[createInstitution]
Reference:	
Notes:	The majority of the files examined used createAgency. Other options were origin or Data Center. More than one create agency listed as csv. This links directly to existing converted netCDF attribute: creator_name

CREATE DATE TIME

Description:	Time and Date that the dataset was created
Data Type:	xsd:dateTime
Length:	N/A
Units:	Mixed Date and Time UTC
Domain:	N/A
Example:	2008-02-10T09:49:16Z
Obligation:	Mandatory
Occurrence:	1
Encoding Tag:	[createDateTime]
Reference:	International Standards Organization. ISO 8601:2000, Data Elements and Interchange Formats – Information Interchange – Representation of Dates and Times. (Format) "CoastWatch HDF." CoastWatch Caribbean Regional Node. USDOC/NOAA/NESDIS/CoastWatch. 05 May 2008 <http://cwcaribbean.aoml.noaa.gov/hdf.html>. (Origin, Date, Time)
Notes:	This links directly to existing converted netCDF attribute: date_created

AQUISITION START DATE TIME

Description:	Date and Time that the image acquisition began
Data Type:	xsd:dateTime
Length:	N/A
Units:	Mixed Date and Time in UTC
Domain:	N/A
Example:	2008-02-10T09:49:16Z
Obligation:	Mandatory
Occurrence:	1
Encoding Tag:	[aquisitionStartDateTime]
Reference:	International Standards Organization. ISO 8601:2000, Data Elements and Interchange Formats – Information Interchange – Representation of Dates and Times. (Format) "CoastWatch HDF." CoastWatch Caribbean Regional Node. USDOC/NOAA/NESDIS/CoastWatch. 05 May 2008 <http://cwcaribbean.aoml.noaa.gov/hdf.html>. (Origin, Date, Time)

Notes: The term ‘startTimeDate’ seemed too ambiguous. This can be derived from existing converted netCDF attribute: time:actual_range

AQUISITION END DATE TIME

Description: Date and Time that the image acquisition ended
Data Type: xsd:dateTime
Length: N/A
Units: Mixed Date and Time in UTC
Domain: N/A
Example: 2008-02-10T09:49:16Z
Obligation: Mandatory
Occurrence: 1
Encoding Tag: [aquisitionEndDateTime]
Reference: International Standards Organization. ISO 8601:2000, Data Elements and Interchange Formats – Information Interchange – Representation of Dates and Times. (Format)
"CoastWatch HDF." CoastWatch Caribbean Regional Node. USDOC/NOAA/NESDIS/CoastWatch. 05 May 2008 <http://cwcaribbean.aoml.noaa.gov/hdf.html>. (Origin, Date, Time)
Notes: The term ‘endTimeDate’ seemed too ambiguous. This can be derived from existing converted netCDF attribute: time:actual_range See Appendix D Figure D-1

SENSOR

Description: The complete name of the sensor employed for the observation, collection, or modeled event.
Data Type: xsd:string
Length: N/A
Units: N/A
Domain: Enumerated in the dictionary in Appendix B Table B-1
Example: MODIS
Obligation: Mandatory
Occurrence: N
Encoding Tag: [sensor]
Reference: Brown, C.W., Connor, L.N., Lillibridge, J.L., Nalli, N.R., and Legeckis, R.V. (2005), An Introduction to Satellite Sensors, Observations, and Techniques, in Remote Sensing of Coastal Aquatic Environments, Technologies, Techniques, and Applications, edited by R.L. Miller et al., pp. 21-50, Springer, Dordrecht, Netherlands, 2005. (Domain)
Notes: More than one sensor to be listed as csv. This links directly to existing converted netCDF attribute: sensor

SENSOR PLATFORM

Description: The complete name of the satellite platform
Data Type: xsd:string
Length: N/A
Units: N/A
Domain: Enumerated in the dictionary in Appendix B Table B-2
Example: Terra
Obligation: Mandatory
Occurrence: N
Encoding Tag: [sensorPlatform]
Reference: Brown, C.W., Connor, L.N., Lillibridge, J.L., Nalli, N.R., and Legeckis, R.V. (2005), An Introduction to Satellite Sensors, Observations, and Techniques, in Remote Sensing of Coastal Aquatic Environments, Technologies, Techniques, and Applications, edited by R.L. Miller et al., pp. 21-50, Springer, Dordrecht, Netherlands, 2005. (Domain)
Notes: More than one sensor platform to be listed as csv. This links directly to existing converted netCDF attribute: satellite

MAP PROJECTION

Description: The method used to represent the curved surface of the earth on a plane
Data Type: xsd:string
Length: N/A
Units: N/A
Domain: Enumerated in the dictionary in Appendix B Table B-3

Example: Mercator
Obligation: Mandatory
Occurrence: 1
Encoding Tag: [mapProjection]
Reference: Snyder, John. Map Projections-A Working Manual. Washington, DC: United States Government Printing Office, 1987. (Description, Domain)
Notes: Map Projection has several sub-elements. Map Projection links directly to existing converted netCDF attribute: projection

ELLIPSOID
- Description: A three dimensional object produced by rotating a two dimensional object about one of the axes.
- Data Type: xsd:string
- Length: 64-bit
- Units: N/A
- Domain: N/A
- Example:
- Obligation: Optional
- Occurrence: 1
- Encoding Tag: [ellipsoid]
- Reference:
- Notes: Sub-element of Map Projection.

LONG OF CENTRAL MERIDIAN
- Description: The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
- Data Type: xsd:real
- Length: 64-bit
- Units: decimal degrees
- Domain: -180.0 <= Longitude of Central Meridian <= 180.0
- Example: 0.0
- Obligation: Optional
- Occurrence: 1
- Encoding Tag: [longCM]
- Reference: Federal Geographic Data Committee. Content Standard for Digital Geospatial Metadata. FGDC-STD-001-1998. Version 2.0. 1 May 2000. Federal Geographic Data Committee. Washington, D.C. (Description, Domain)
- Notes: Sub-element of Map Projection.

LAT OF TRUE SCALE
- Description: Latitude that distance measurements are correct.
- Data Type: xsd:real
- Length: 64-bit
- Units: decimal degrees
- Domain: -90.0 <= Latitude of True Scale <= 90.0
- Example: 0.0
- Obligation: Optional
- Occurrence: 1
- Encoding Tag: [latTS]
- Reference:
- Notes: Sub-element of Map Projection. Generally, a Mercator Map Projection will have the Latitude of True Scale set to the center of the image.

FALSE EASTING
- Description: The valued added to all “x” values in the rectangular coordinates for a map projection.
- Data Type: xsd:real
- Length: 64-bit
- Units: N/A
- Domain: N/A
- Example: 0.0
- Obligation: Optional
- Occurrence: 1
- Encoding Tag: [falseEasting]

Reference: Federal Geographic Data Committee. Content Standard for Digital Geospatial Metadata. FGDC-STD-001-1998. Version 2.0. 1 May 2000. Federal Geographic Data Committee. Washington, D.C. (Description)
Notes: Sub-element of Map Projection.

FALSE NORTHING
Description: The value added to all “y” values in the rectangular coordinates for a map projection.
Data Type: xsd:real
Length: 64-bit
Units: N/A
Domain: N/A
Example: 0.0
Obligation: Optional
Occurrence: 1
Encoding Tag: [falseNorthing]
Reference: Federal Geographic Data Committee. Content Standard for Digital Geospatial Metadata. FGDC-STD-001-1998. Version 2.0. 1 May 2000. Federal Geographic Data Committee. Washington, D.C. (Description)
Notes: Sub-element of Map Projection.

STANDARD PARALLEL
Description: Line of constant latitude at which surface of the Earth and the plane or developable surface intersect
Data Type: xsd:real
Length: 64-bit
Units: N/A
Domain: -90.0 <= Standard Parallel <= 90.0
Example: 0.0
Obligation: Optional
Occurrence: N
Encoding Tag: [stdParll]
Reference: Federal Geographic Data Committee. Content Standard for Digital Geospatial Metadata. FGDC-STD-001-1998. Version 2.0. 1 May 2000. Federal Geographic Data Committee. Washington, D.C. (Description, Domain)
Notes: Sub-element of Map Projection.

GEODETIC DATUM
Description: Defines the reference coordinate system for remotely sensed observation
Data Type: xsd:string
Length: 64-bit
Units: N/A
Domain: Enumerated in the dictionary in Appendix B Table B-4 or in GCTP software
Example: WGS 84
Obligation: Mandatory
Occurrence: 1
Encoding Tag: [geodeticDatum]
Reference: Maginnies, Thomas. "Affirmation of Datum for Surveying and Mapping Activities." Federal Register Vol. 54, No. 11314 June 1989 06 May 2008 <http://www.ngs.noaa.gov/PUBS_LIB/FedRegister/FRdoc89-14076.pdf>.(Domain)
United States Geologic Survey. General Cartographic Transformation Package (GCTP). USGS. < ftp://edcftp.cr.usgs.gov/pub/software/gctpc/>. (Domain)
Wilson, W. Stanley. "Affirmation of Datum for Surveying and Mapping Activities." Federal Register Vol. 58, No. 12024 June 1993 20 May 2008 <http://www.ngs.noaa.gov/PUBS_LIB/FedRegister/FRdoc93-14922.pdf>. (Domain)
Notes: Dictionary entries are normative. This item can be derived from the existing converted netCDF attribute: gctp_datum

PIXEL SIZE
Description: Geographic dimensions corresponding to the smallest single component of an image

Data Type: xsd:real
Length: 64-bit
Units: N/A
Domain: N/A
Example: 1000.0 meters
Obligation: Optional
Occurrence: 1
Encoding Tag: [pixelSize]
Reference:
Notes:

INPUT FILES
Description: Files used to produce the dataset; the history of the dataset.
Data Type: xsd:string
Length: N/A
Units: N/A
Domain: N/A
Example: A2008100.L3m_DAY_CHLO_9.hdf
Obligation: Optional
Occurrence: N
Encoding Tag: [inputFiles]
Reference:
Notes: The most commonly used term was inputFile. Other option was history. Calibration history files should be included. More than one input file to be listed as csv. A subset of input files are captured in the existing netCDF attribute: history

LATITUDE
Description: An array of northing values for horizontal positions of the observation
Data Type: gml:PointPropertyType
Length: 64-bit
Units: decimal degrees (degrees_north)
Domain: 0 to -90, 0 to 90
Example: 88.12345
Obligation: Optional
Occurrence: N
Encoding Tag: [Latitude]
Reference: International Standards Organization. ISO 6709:1983. Standard Representation of Latitude, Longitude and Altitude for Geographic Point Locations. (Units)
Notes: Positive sign inferred. Values south of the equator shall include the negative sign. More than one latitude to be listed as csv. degrees_north This item exists as a data variable in the converted netCDF files: latitude

LONGITUDE
Description: An array of easting values for the horizontal positions of the observation
Data Type: gml:PointPropertyType
Length: 64-bit
Units: decimal degrees (degrees_east)
Domain: 0 to -90, 0 to 90
Example: 88.12345
Obligation: Optional
Occurrence: N
Encoding Tag: [Longitude]
Reference: International Standards Organization. ISO 6709:1983. Standard Representation of Latitude, Longitude and Altitude for Geographic Point Locations. (Units)
Notes: Positive sign inferred. Values south of the equator shall include the negative sign. More than one longitude to be listed as csv. degrees_east This item exists as a data variable in the converted netCDF file: longitude

NORTHERN LATITUDE
Description: Northern-most coordinate of the limit of coverage expressed in latitude
Data Type: gml:PointPropertyType
Length: 64-bit
Units: decimal degrees
Domain: 0 to -90, 0 to 90
Example: 88.12345

Obligation: Mandatory
Occurrence: 1
Encoding Tag: [northernLatitude]
Reference: Federal Geographic Data Committee. Content Standard for Digital Geospatial Metadata. FGDC-STD-001-1998. Version 2.0. 1 May 2000. Federal Geographic Data Committee. Washington, D.C. (Description, Domain, Units) International Standards Organization. ISO 6709:1983. Standard Representation of Latitude, Longitude and Altitude for Geographic Point Locations. (Units)
Notes: Positive sign inferred. Values south of the equator shall include the negative sign. This item exists as an attribute in the converted netCDF: Northernmost_Northing

SOUTHERN LATITUDE
Description: Southern-most coordinate of the limit of coverage expressed in latitude
Data Type: gml:PointPropertyType
Length: 64-bit
Units: decimal degrees
Domain: 0 to -90, 0 to 90
Example: 87.12345
Obligation: Mandatory
Occurrence: 1
Encoding Tag: [southernLatitude]
Reference: Federal Geographic Data Committee. Content Standard for Digital Geospatial Metadata. FGDC-STD-001-1998. Version 2.0. 1 May 2000. Federal Geographic Data Committee. Washington, D.C. (Description, Domain, Units) International Standards Organization. ISO 6709:1983. Standard Representation of Latitude, Longitude and Altitude for Geographic Point Locations. (Units)
Notes: Positive sign inferred. Values south of the equator shall include the negative sign. This item exists as an attribute in the converted netCDF: Southernmost_Northing

WESTERN LONGITUDE
Description: Western-most coordinate of the limit of coverage expressed in longitude
Data Type: gml:PointPropertyType
Length: 64-bit
Units: decimal degrees
Domain: 0 to -180, 0 to 180
Example: -170.12345
Obligation: Mandatory
Occurrence: 1
Encoding Tag**:** [westernLongtitude]
Reference: Federal Geographic Data Committee. Content Standard for Digital Geospatial Metadata. FGDC-STD-001-1998. Version 2.0. 1 May 2000. Federal Geographic Data Committee. Washington, D.C. (Description, Domain, Units) International Standards Organization. ISO 6709:1983. Standard Representation of Latitude, Longitude and Altitude for Geographic Point Locations. (Units)
Notes: Positive sign inferred. Values west of the prime meridian shall include the negative sign. This item exists as an attribute in the converted netCDF: Westernmost_Easting

EASTERN LONGITUDE
Description: Eastern-most coordinate of the limit of coverage expressed in longitude
Data Type: gml:PointPropertyType
Length: 64-bit
Units: decimal degrees
Domain: 0 to -180, 0 to 180
Example: -170.12345
Obligation: Mandatory
Occurrence: 1
Encoding Tag**:** [easternLongitude]
Reference: Federal Geographic Data Committee. Content Standard for Digital Geospatial Metadata. FGDC-STD-001-1998. Version 2.0. 1 May 2000. Federal Geographic Data Committee. Washington, D.C. (Description, Domain, Units)

	International Standards Organization. ISO 6709:1983. Standard Representation of Latitude, Longitude and Altitude for Geographic Point Locations. (Units)
Notes:	Positive sign inferred. Values west of the prime meridian shall include the negative sign. This item exists as an attribute in the converted netCDF: Easternmost_Easting

OBSERVED PROPERTY

Description:	Defines the parameter or variable measured or calculated
Data Type:	xsd:string
Length:	64-bit
Units:	Enumerated in the dictionary in Appendix B Table B-5
Domain:	Enumerated in the dictionary in Appendix B Tables B-5 and B-6
Example:	Chlorophyll concentration
Obligation:	Mandatory
Occurrence:	N
Encoding Tag:	[observedProperty]
Reference:	Arnone, R.A., and Parsons, A.R. (2005), Real-Time Use of Ocean Color Remote Sensing for Coastal Monitoring, in Remote Sensing of Coastal Aquatic Environments, Technologies, Techniques, and Applications, edited by R.L. Miller et al., pp. 317-337, Springer, Dordrecht, Netherlands, 2005. (Domain) Feldman, Gene. "OceanColor Products." OceanColor Web. 24 JAN 2007. NASA Goddard Space Flight Center. 06 May 2008 <http://oceancolor.gsfc.nasa.gov/PRODUCTS/>.
Notes:	Dictionary entries are informative. This item already exists in the converted netCDF files as variable definition: float chlor_a

OBSERVED PROPERTY ALGORITHM

Description:	Algorithm used to compute observed property
Data Type:	xsd:string
Length:	N/A
Units:	N/A
Domain:	N/A
Example:	OC3
Obligation:	Mandatory
Occurrence:	1
Encoding Tag:	[observedPropertyAlgorithm]
Reference:	
Notes:	Necessary to identify how the values were derived if compared to other satellite derived data or *in situ*.

PROCESSING LEVEL

Description:	Defines the status of the result as defined by data provider classifications
Data Type:	xsd:string
Length:	64-bit
Units:	N/A
Domain:	Enumerated in the dictionary in Appendix B Table B-7
Example:	Level 2
Obligation:	Mandatory
Occurrence:	1
Encoding Tag:	[processingLevel]
Reference:	Federal Geographic Data Committee. FGDC-STD-012-2002. Content Standard for Digital Geospatial Metadata: Extensions for Remote Sensing Metadata. Federal Geographic Data Committee. Washington, D.C. (Domain)
Notes:	This links directly to existing converted netCDF attribute: processing_level

PROCESSING FLAGS

Description:	The flag applied to a pixel when certain tests and conditions are met
Data Type:	xsd:string
Length:	64-bit
Units:	N/A
Domain:	Enumerated in the dictionary in Appendix B Table B-8
Example:	LAND
Obligation:	Optional
Occurrence:	N
Encoding Tag:	[processingFlags]

Reference: Patt, Frederick, et al. "Algorithm Updates for the Fourth SeaWiFS Data Reprocessing." NASA Technical Memorandum 2003-206892, Volume 22(2003) 06 May 2008 <http://oceancolor.gsfc.nasa.gov/SeaWiFS/TECH_REPORTS/PLVol22.pdf>. (Domain)
Notes: More than one processing flag to be listed as csv. This is an SDS data array containing the values of the l2_flags for each pixel.

NUMBER OF SPECTRAL BANDS
Description: The number of spectral bands used in the algorithm
Data Type: xsd:integer
Length: 64-bit
Units: N/A
Domain:
Example: 8
Obligation: Optional
Occurrence: N
Encoding Tag: [numberofSpectralBands]
Reference:
Notes:

WAVELENGTHS
Description: Center wavelength of spectral bands used in the algorithm
Data Type: xsd:float
Length: 64-bit
Units: nanometers (nm)
Domain:
Example: 551
Obligation: Optional
Occurrence: N
Encoding Tag:
Reference: [wavelengths]
Notes: More than one wavelength to be listed as csv.

BANDWIDTHS
Description: The width of the spectral bands
Data Type: xsd:float
Length: 64-bit
Units: nanometers (nm)
Domain:
Example: 10
Obligation: Optional
Occurrence: N
Encoding Tag: [bandwidths]
Reference:
Notes: More than one bandwidth to be listed as csv.

ATM CORRECTION
Description: Algorithm used to remove the atmospheric effects from the optical characteristics of the imagery
Data Type: xsd:string
Length: N/A
Units: N/A
Domain: N/A
Example: SeaWiFS/MODIS algorithm (Gordon and Wang ,1994)
Obligation: Optional
Occurrence: 1
Encoding Tag: [atmCorrection]
Reference: Feldman, Gene. " Atmospheric Correction and Aerosol Models." OceanColor Validation. 12 APR 2005. NASA Goddard Space Flight Center. 05 May 2008 <http://oceancolor.gsfc.nasa.gov/VALIDATION/atm.html>.(Figure and explanation)
Notes: See Appendix E Figure E-1

CALIBRATION

Description:	Type or version of calibration applied to the new satellite imagery during processing
Data Type:	xsd:string
Length:	N/A
Units:	N/A
Domain:	N/A
Example:	Version of MODIS calibration look-up tables [4.0.XX] OR perhaps cross calibration with another sensor (e.g. OCM with SeaWiFS)
Obligation:	Optional
Occurrence:	1
Encoding Tag:	[calibration]
Reference:	
Notes:	

ANCILLARY DATA

Description:	Additional information used in the processing such as description of and references to ancillary data sets used
Data Type:	xsd:string
Length:	N/A
Units:	N/A
Domain:	N/A
Example:	APS v3.4.3 i686-pc-linux-gnu
Obligation:	Optional
Occurrence:	1
Encoding Tag:	[ancillaryData]
Reference:	
Notes:	

Appendix A: Example

The example below demonstrates a completed remotely sensed ocean color record.

TABLE A-1 Overview of a Chlorophyll Record

Element	Example
CREATE INSTITUTION	Naval Research Laboratory, Stennis Space Center
CREATE DATE TIME	2008-05-11T18:43:49Z
AQUISITION START DATE TIME	2008-05-11T16:45:07Z
ACQUISITION END DATE TIME	2008-05-11T16:48:13Z
SENSOR	MODIS
SENSOR PLATFORM	Terra
MAP PROJECTION	Mercator
ELLIPSOID*	
LONG OF CENTRAL MERIDIAN*	
LAT OF TRUE SCALE*	
FALSE EASTING*	0.0
FALSE NORTHING*	0.0
STANDARD PARALLEL*	0.0
GEODETIC DATUM	WGS-84
PIXEL SIZE*	1000.0 meters
INPUT FILES*	MOD021KM.A2008132.1645.NOAA
LATITUDE*	30.999999999999996,27.49112206938089,24.06513101901263, 21.799556291562,18.115694947674196,14.984412804864494
LONGITUDE*	-99.000000000000,-95.18809404702351,-91.46623311655827, -89.00500250125063,-85.00300150075037,-79.000000000000
NORTHERN LATITUDE	30.999999999999996
SOUTHERN LATITUDE	14.984412804864494
WESTERN LONGITUDE	-99.000000000000000
EASTERN LONGITUDE	-79.000000000000000
OBSERVED PROPERTY	Chlorophyll Concentration
OBSERVED PROPERTY ALGORITHM	OC3
PROCESSING LEVEL	Level 3
PROCESSING FLAGS*	HIGLINT
NUMBER OF SPECTRAL BANDS*	9
WAVELENGTHS*	412.5,443.0,488.0,531.0,551.0,667.0,678.0,748.0,869.5
BANDWIDTHS*	15.0,10.0,10.0,10.0,10.0,10.0,10.0,10.0,15.0
ATM CORRECTION*	Multiple scattering aerosol model with 7/8 algorithm & NIR iteration with up to 10 iterations
CALIBRATION*	MODIS L1B LUT 5.0.40.4
ANCILLARY DATA*	APS v3.4.3 i686-pc-linux-gnu

* indicates optional elements

Appendix B: Element Domains and Common Properties

This Appendix contains several tables that identify valid domains and common properties for identified elements within the ocean color data dictionary.

Table B-1: Sensor Domain List: Modern visible infrared satellite sensor characteristics from Brown et al. (2005)

Sensor / Mission	Dates of Operation	Resolution (m)	Number of Vis-NIR Bands
MERIS	03/01/2002 -	300/1200	15
MODIS	Terra 12/18/1999 - Aqua 05/04/2002 -	250/500/1000	2/5/12
OCM	05/26/1999 -	350	8
SeaWiFS	08/01/1997 -	1100	8

Table B-2: Sensor Platform Domain List: Modern visible infrared satellite sensor characteristics from Brown et al. (2005)

Satellite / Platform	Dates of Operation	Resolution (m)	Number of Vis-NIR Bands
ENVISAT - 1	03/01/2002 -	300/1200	15
Terra	12/18/1999 – 05/04/2002 -	250/500/1000	2/5/12
Aqua	12/18/1999 – 05/04/2002 -	250/500/1000	2/5/12
IRS-P4	05/26/1999 -	350	8
OrbView 2	08/01/1987 -	1100	8

Table B-3: Domain list for map projections from Snyder (1987).

Name	Properties
Albers Conical Equal Area	Distorts scale and distance, standard parallels are true.
Azimuthal Equidistant	Distance and direction are true at the center point. Distortion of properties of area and shape increases away from center point.
Ellipsoid	Mathematical model describing the shape of the earth.
Equidistant Conic	Direction, area, and shape are distorted away from standard parallels. Distances are true along meridians.
Geodetic Datum	Location on the earth's surface where mapping coordinates originate.
Gnomonic	Directions are true from center point of projection. Shapes and areas are distorted away from center point.
Lambert Azimuthal Equal Area	Directions are true from center point of projection. Shapes are distorted away from center point. The central meridian is a straight line, others are curved.
Lambert Conformal Conic	Distances are true along standard parallels. Shapes and areas are distorted away from standard parallels.
Mercator	Large areas have distorted area and shape. Small areas are true. Distortion increases from equator. Straight meridians and parallels intersect at right angles. Scale is true at the equator or at two standard parallels equidistant from the equator.
Miller Cylindrical	Directions are true along the equator. Distances, shapes, and areas are distorted at high latitudes. Straight meridians and parallels meet at right angles, straight lines are not of constant azimuth. Shapes and areas are distorted.
Oblique Mercator	Distances are true along a great circle and the oblique cylinder. Distances, areas, and shapes are distorted away from the great circle.
Orthographic	Direction is true at center point. Distances are true along the equator and other parallels. Areas and shapes are distorted away from the center point.
Polar Stereographic	Directions are true from the center point. Scale, areas, and shapes are distorted away from the center point.
Polyconic	Directions, scale, shapes, and areas are true along the central meridian. Distortion increase away from the central meridian. The central meridian is straight. Other meridians are curved.
Robinson	Directions are true along the central meridian and all parallels. Shapes, areas, scale, and distances are distorted to balance the errors of projection properties.
Sinusoidal	Scale is true on the central meridian and the parallels. Shapes are distorted away from the central meridian and near the poles.
Space Oblique Mercator	Distances are true along a great circle and the oblique cylinder. There is no distortion along the satellite groundtrack.
Stereographic	Directions are true at the center point. Scale, areas, and shapes are distorted away from the center point.
Transverse Mercator	Distances are true along the central meridian or two lines parallel to the central meridian. Scale, distances, directions and areas are distorted away from the central meridian.

Table B-4: Code list for datum from Maginnies (1989) and Wilson (1993)

Category	Name	Definition
Ellipsoidal	NAD83	North American Datum 1983 (1986)
Ellipsoidal	WGS84(G1150)	World Geodetic System 1984 (G1150)
Ellipsoidal	WGS84(G873)	World Geodetic System 1984 (G873)
Ellipsoidal	WGS84(G730)	World Geodetic System 1984 (G730)
Ellipsoidal	WGS84	World Geodetic System 1984 (original system – 1984)
Ellipsoidal	WGS72	World Geodetic System 1972
na	Undefined	Ambulatory or otherwise undefined

Table B-5: Common bio-optical and satellite derived ocean color validated products from Arnone, R.A., and Parsons, A.R. (2005)

Validated Products	Description	Units
Chlorophyll concentration	Biological processes such as algal (harmful and non-harmful) blooms and decay	mg m^{-3}
Spectral backscattering coefficient	90 to 180 degree particle scattering linked to concentration, composition, index of refraction of organic (marine) and inorganic (terrigenous) particles; resuspension of particles	m^{-1}
Spectral absorption coefficient	Total absorption, changes in water quality	m^{-1}
Spectral absorption colored dissolved organic matter	Conservative tracer of river plumes, linked with coastal salinity, photo-oxidation processes	m^{-1}
Spectral particle absorption coefficient	Particle composition, (organic and inorganic particles)	m^{-1}
Spectral phytoplankton absorption coefficient	Absorption linked to differences in chlorophyll packaging within phytoplankton cells	m^{-1}
Remote sensing reflectance	Spectral absolute water color and water signature	sr^{-1}
Diffuse attenuation coefficient	Light penetration depth, light availability at depth	m^{-1}
Aerosol concentration – Epsilon	Type and distribution, affects visibility, atmospheric correction methods	Unitless
Beam attenuation coefficient	Total light attenuation using a collimated beam	m^{-1}
Diver visibility	Horizontal visibility, average target size, target contrast, solar overhead illumination	m
Laser penetration	Underwater performance of lasers (imaging or bathymetry systems)	m
Sea surface temperature	Skin temperature / bulk temperature (MODIS)	C

Table B-6: Common bio-optical and satellite derived ocean color exploratory products from Arnone and Parsons (2005)

Exploratory Products	Description
Surface Salinity	Absorption at 412 nm or CDOM absorption in coastal areas with high surface gradients
Particle size distribution (junge distribution) and concentration	Spectral backscattering coefficient in coastal waters, concentration at different sizes
Particulate Organic Matter (POM)	α(detritus @443 nm) to estimate carbon flux
Particulate Inorganic Matter (PIM)	α(detritus @412 nm) to estimate particle flux
Total Particle Concentration	Particle composition (organic / inorganic particles), regional dependent
Particle organic / inorganic ration for each size class	Particle fluxes in surface water, settling, and resuspension
Satellite water mass optical classification	Identification of specific water masses using optical signature and tracking movements
Satellite products integrated with numerical models of currents	Interpreting how physical processes (advection) affect the bio-optical response (e.g., advection of chlorophyll blooms)
Vertical profiles of bio-optical properties	Determined by assimilating modeled mixed layer depth with the satellite surface chlorophyll
Primary Production	Determined through linked seasonal SST and chlorophyll fluorescence

Table B-7: Processing Data Levels as defined by NOAA from FGDC-STD-012-2002

Processing Level	Description
Level 0	Level 0 data products are unprocessed telemetry data as received from the observing platform excluding communications artifacts introduced by the ground system
Level 1a	Level 1a data products are telemetry data that have been extracted but not decommutated from Level 0 and formatted into time-sequenced datasets for easier processing. The Level 1a formats are NOAA's internal formats and are only used for NOAA processing. They only exist briefly for the purpose of creating the Level 1b datasets. Levels 2-4 are the same as NASA levels 2-4.
Level 1b	Level 1b data products are discrete, instrument-specific datasets derived from Level 1a containing unprocessed data at full resolution, time-referenced, and annotated with ancillary information including data quality indicators, calibration coefficients and georeferencing parameters.
Level 2	Level 2 data products are derived geophysical variables at the same resolution and locations as the Level 1 source data.
Level 3	Level 3 data products are variables mapped on uniform space-time grid scales, usually with some completeness and consistency.
Level 4	Level 4 data products are model output or results from analyses of lower level data, e.g. variables derived from multiple measurements.

Table B-8: Level -2 and Level -3 Processing Flags from Patt et al. (2008)

Name	Units
ATMFAIL	Atmospheric correction failure
LAND	Pixel is over land
BADANC	Reduced quality of ancillary data
HIGLINT	High sun glint
HILT	Observed radiance very high or saturated
HISATZEN	High sensor view zenith angle
COASTZ	Pixel is in shallow water
NEGLW	Negative water-leaving radiance retrieved
STRAYLIGHT	Straylight contamination is likely
CLDICE	Probable cloud or ice contamination
COCCOLITH	Coccolithofores detected
TURBIDW	Turbid water detected
HISOLZEN	High solar zenith
HITAU	High aerosol optical thickness
LOWLW	Very low water-leaving radiance (cloud shadow)
CHLFAIL	Derived product algorithm failure
NAVWARN	Navigation quality is reduced
ABSAER	Possible absorbing aerosol (disabled)
TRICHO	Possible trichodesmium contamination
MAXAERITER	Aerosol iterations exceeded max
MODGLINT	Moderate sun glint contamination
CHLWARN	Derived product quality is reduced
ATMWARN	Atmospheric correction is suspect
DARKPIXEL	Rayleigh-subtraced radiances is negative
SEAICE	Possible sea ice contamination
NAVFAIL	Bad navigation
FILTER	Pixel rejected by user-defined filter
SSTWARN	SST quality is reduced
SSTFAIL	SST quality is bad
HIPOL	High degree of polarization
OCEAN	Not cloud or land

Appendix C: Ocean Color Products

The table below lists all of the types of ocean color products and sources of the products reviewed. Multiple datasets were evaluated from each product type.

Table C-1: Ocean Color reviewed products- informative

Products	Source
Terra/Aqua MODIS Chlorophyll Products (NASA SeaDAS)	CoastWatch http://coastwatch.noaa.gov/interface/most_recent.php?sensor=MODIS&product=chlorNASA
Climatological Aqua-MODIS	NASA Goddard http://oceancolor.gsfc.nasa.gov/cgi/climatologies.pl
Climatological Terra-MODIS	NASA Goddard http://oceancolor.gsfc.nasa.gov/cgi/climatologies.pl
Climatological SeaWiFS	NASA Goddard http://oceancolor.gsfc.nasa.gov/cgi/climatologies.pl
MERIS Level 2 Ocean Color	ftp://ftp.aoml.noaa.gov/pub/phod/trinanes/IOOS/
OCM Level 1	Naval Research Laboratory, Stennis Space Center
OCM Level 3	Naval Research Laboratory, Stennis Space Center
MODIS Level 3	NOAA Cooperative Institute OPeNDAP Server http://pontchartrain.ssc.hpc.msstate.edu/opendap_index.html
MODIS Level 4	NOAA Cooperative Institute OPeNDAP Server http://pontchartrain.ssc.hpc.msstate.edu/opendap_index.html

Appendix D: Data Acquisition Time

The figure below illustrates satellite acquisition start and end times. The satellite will start remotely sensing the earth in a beginning location at a start time. When the satellite sensor sweeps and finishes scanning at the end of a particular segment, the time that it finishes is the acquisition end time. For example, a MODIS granule consists of 5 minutes of swath data along the MODIS ground track.

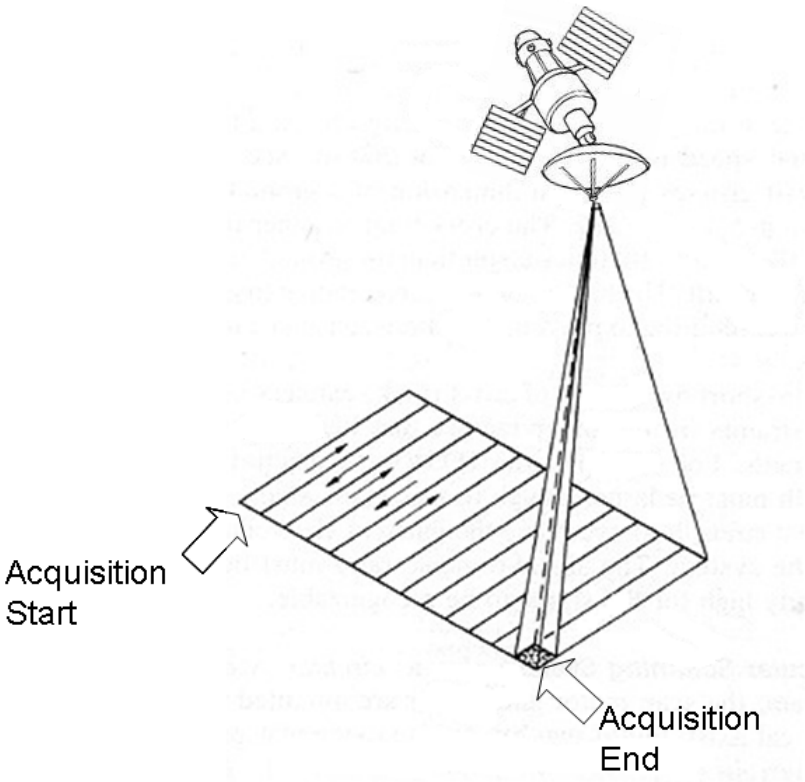

Figure D-1: Acquisition start and end time – informative

Appendix E: Atmospheric Correction

The figure below illustrates the effects of ocean surface scattering and atmospheric conditions on the total radiance. Roughly, only about 10% of the total radiance is the ocean signal. Atmospheric correction removes the effects of ocean surface scattering and atmospheric conditions such as aerosols and gases from the total radiance leaving quantitative estimates of water constituents. Multiple variables are involved in calculating atmospheric correction.

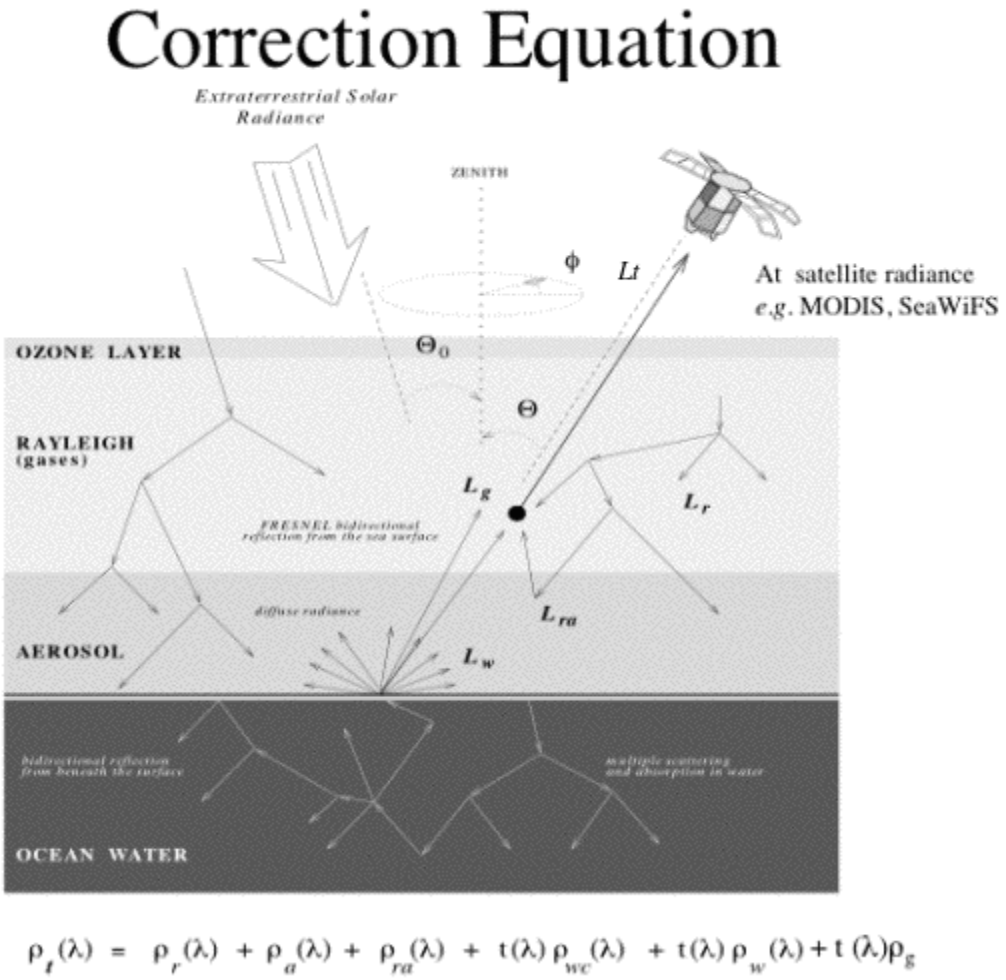

Figure E-1: General atmospheric correction equation from Feldman (2005) - informative

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